Strategies for Managing Complexity in Construction Projects
Written by Matthew Winchur, September 2019

This is the second article of a three-part series that investigates how the field of complexity is applied in projects in the Construction sector. In the first article, the basics of complexity were translated to Construction projects. A framework of how the emergent risk trend from complexity affected a project was created demonstrating that complexity ‘ebbs and flows’ over a project’s lifecycle.

In this second article, an enterprise framework including a Portfolio Management Office (PMO), will be central to creating a sensitivity to complexity in the environment. New project team capabilities and behaviours critical to managing the risk from this complexity will be defined. Strategies and tactics for aligning the right resources and processes with the environment will be provided.

This will then lead into the last article of the three-part series that will focus on how the framework and toolkit should be aligned with modern digital practices. This alignment will enable enterprise architecture strategies, technologies, and practices, to improve the speed of interpretation and management of complexity. This increased agility will lead to improved project performance.

Review of the Basics of Complexity
In the first article we characterised the construction environment (which has similarities to other sector environments) as one where entities are interrelated, leading to dynamic, uncertain, and often ambiguous conditions. The result is that any event can potentially create unpredictable effects. We defined these as complex adaptive systems that share fundamental behaviours such as emergence, adaptive self-organisation, and information processing.

We then applied the basics of complexity theory to Construction sector projects, focusing on Design, Construction, and Commissioning phases, and defined complexity by four key aspects:

1. Structural complexity resulting from scale and the level of interconnected tasks and activities in a project.
2. Technical complexity derived from the unique design challenges or techniques without precedent.
3. Directional complexity resulting from hidden agendas or mis-aligned goals. It can be exacerbated by multiple layers of external stakeholders (e.g. Federal, State, agents)
4. Temporal complexity from extended periods of time with uncertainty from shifting environmental conditions.

Activities in the Design, Construction, and Commissioning phases (e.g. engagement of State & Federal authorities, onboarding of team members, design activities, etc.) were used to define an output Complexity risk trend. A summary showing all four trends is below:

![Figure 1: Complexity risk trends in Construction project life cycle phases](image)

The conclusion of the first paper was that complexity is not a static characteristic of a project but ebbs and flows over time.
Identifying an Enterprise Approach

Businesses that engage in Construction projects typically have a portfolio of projects that range in size, risk profile, and complexity. In order to maximise the return on investment, the following five factors are likely to be the primary drivers when choosing an approach for managing complexity across an enterprise.

1. Existing expertise in complexity management.
   - Does the organisation have an inherent level of understanding of complexity?
   - What is the maturity level of existing risk management practices?
   - How easily could practices in an adjacent sector be leveraged?

2. Bureaucracy layers and decision making.
   - Do agility and adaptiveness play a large role in the current culture?
   - How formalised are decision making processes?
   - What level of delegation exists between top-level management and the workers?

3. Maturity of systems and procedures.
   - Is there an enterprise quality system and how does this link to project controls?
   - Are processes and systems integrated or referenced separately?
   - How robust is the stage gate workflow for projects?

4. Function of the Portfolio Management Office (PMO) if one exists.
   - Where does it report through in the business (departmental or corporate)?
   - What skillset exists in the team?
   - What type of influence does it have (directive vs. supportive)?

5. Commercial profile of projects.
   - Whether the business takes a risk position on commercial outcomes (vs. a fee)?
   - Do the projects self-perform or subcontract works?
   - How much risk has been pushed from the client to the project?

The day-to-day business challenges that line-management deal with can be considered the baseline of complexity that the business is comfortable to manage. The need for further complexity management expertise may result from a deliberate step into a new sector or market with greater risk and reward. It could also result from a realisation that a gap in the base-level of expertise has appeared over time in current projects.

The nuances of each business, their supporting capabilities, and environment will generate unique challenges. An enterprise framework provides principles and practices in how an organisation operates.

Enterprise Framework for Managing Complexity

A PMO usually sets the policy and the operational risk controls (project reviews, cost planning systems, schedule coding requirements, etc.) for project delivery in construction firms. Data from these risk controls (financial and non-financial) is collected for each project.

Multiple projects are then combined into a portfolio where analysis by geography or by time may produce insights that are not possible by looking at the projects individually. The PMO is usually responsible for reporting portfolio analysis to the executive management team, while remaining free from the burden of winning work and maintaining disciplined delivery. The combination of project and portfolio understanding will allow the PMO to have an objective view properly balanced between detail and big picture that will help in managing complexity.

Capabilities need to be developed within the PMO team to enable them to analyse and react to complexity risks. The lead person that will be given accountability for the management of complexity should have a high level of understanding of the business. They can be supported by experts or consultants but the translation from the theory to practical applications must be done by a practitioner. The number of practitioners required, and their level of expertise will be determined by the business needs.
Creating a Sensitivity to Complexity

Creating sensitivity to complexity in the operational risk controls requires additional reporting measures for each project. These measures can then be evaluated at both project and portfolio level. The same considerations that drive the ebb and flow of complexity as identified in the first article should be used here. Some examples of these drivers of complexity in Construction projects:

- Interrelated processes from Federal and State authorities
- Utilities (water, electricity, gas), including potential network disruptions
- Independent verifiers (e.g. environmental, fire safety, etc.)
- Ambiguity around alternative options for technical challenges
- Integration between technical solutions and the larger systems
- Management constraints (e.g. location impacts, experience level, key staff turnover)

For these and other measures, the business must identify individual thresholds as well as interface thresholds. The latter is needed because when two or more risk factors combine, a non-linear effect may occur. For example, the resulting complexity from a technical challenge that involves a utility provider and an independent verifier may be much greater than the sum of each if considered individually.

Situation Evaluation

Numerous techniques have been identified to facilitate the identification and classification of complexity, see Remington and Pollack (2007) Tools for Complex Project for examples. It is critical that a common understanding of the challenges exists and that they are reflective of the actual situation.

The project team’s ability to continually evaluate their situation over the project life is important to assess. Situational awareness is defined across three attributes (Endsley & Jones, 2012).

1. Perception of needed data – the ability to distinguish the attributes and dynamics of the relevant elements in the environment. This can be impacted by attention tunnelling, the range of simultaneous information modalities, and pattern matching abilities.

<table>
<thead>
<tr>
<th>Example risk factor</th>
<th>Attention tunnelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The project team are too focused on certain information or features of the environment and no longer keep a high-level view of what’s happening across the board.</td>
</tr>
</tbody>
</table>
| How this can impact the project | In Design: Fewer options identified for technical challenges  
In Construction: Tasks delegated incorrectly or without proper support  
In Commissioning: Reduced effectiveness of planning activities |
| Impact to complexity | Structural complexity: continual firefighting results in a higher likelihood of unknown risks impacting the project.  
Technical complexity: sunk costs make altering course a significant challenge.  
Directional complexity: a person or team, while adequately skilled, may not be able to cope with the volume or velocity of risks they are facing.  
Temporal complexity: overuse of committees or the over-analysis of the situation may reduce decision making abilities. |
2. Comprehension of information – understanding what the data perceived means in relation to the relevant goals and objectives. This can be impacted by reaching stress thresholds, automation, and a miscalculation of the time available.

<table>
<thead>
<tr>
<th>Example risk factor</th>
<th>Stress thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Psychological factors such as time pressures and mental workload, as well as physical factors such as fatigue and high levels of noise.</td>
</tr>
<tr>
<td>How this can impact the project</td>
<td>Once a stress threshold is reached, a person’s ability to comprehend the current situation is no longer determined by their skill but by their state.</td>
</tr>
<tr>
<td>Impact to complexity</td>
<td>This can impact all four aspects of complexity by the potential misreading of a situation.</td>
</tr>
</tbody>
</table>

3. Projection of future scenarios – the ability to predict what the elements will do in the future. This can be impacted by reaching the capacity of resources (e.g. data overload), or insufficient knowledge of the domain.

<table>
<thead>
<tr>
<th>Example risk factor</th>
<th>Data overload</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Runaway feedback loops from a rapid rate of change (either due to the velocity of risks being faced or other changes) that creates a need for more and more information which eventually goes beyond the person’s or team’s capacity to process it.</td>
</tr>
<tr>
<td>How this can impact the project</td>
<td>Future scenarios are no longer generated as the information is known not to be current.</td>
</tr>
<tr>
<td>Impact to complexity</td>
<td>This can impact all four aspects of complexity as value diminishes from efforts in planning activities.</td>
</tr>
</tbody>
</table>

Containment and recovery strategies for factors impacting a project team’s situational awareness is highly dependent on the nuance of the situation. In some instances, it could be as simple as a structured process to call out missing information between teams or individuals. Alternatively, more sophisticated techniques such as a ‘link analysis’ to assess the quality of the relationships between networked teams, is needed. The PMO as a skilled facilitator will be in the best position to make a call on which techniques are best suited.

**Matching Project Team Capability vs. Environment**

Forecasting the performance of an individual for a role is usually subjectively assessed by their familiarity with similar projects. This is used to infer an ability to make good choices. In complex projects familiarity alone may not equate to the same level of confidence in outcomes. Sound principles and an ability to recognise patterns becomes more important as complexity increases further increasing the importance of experience.

In Construction projects, there are four roles that are critical to driving ‘bottom-line’ outcomes.
- **Project Director / Leader:** The most senior staff member directly responsible for the project.
- **Commercial Manager:** Responsible for financial and legal term positions for external agreements and ensuring head contract requirements are met
- **Cost Planner:** Accountable for how design decisions will meet the budget constraints
- **Planner:** Accountable for the schedule and integration of activities

Either by direct interviewing or through network mapping, an assessment of the relationship between each of these roles should be done.

Where each role sits in the project organisation chart is important. There is no single best way to structure a project, a combination of hierarchy and network structures is needed.
A requirement for specialist skills can either be kept in a single unit or distributed across units dependent on coordination needs. The strengths and weaknesses of the project staff, availability of people to fill pivotal roles, and numbers of direct reports are examples of factors that can impact a project structure.

Networked teams cannot thrive without input from the upper levels of the hierarchy. Accountabilities for network units and reporting requirements must be defined. Guidance should also be provided on lateral relationships as well as a process to follow when facing challenges (Goold & Campbell, 2002). Aligning the capabilities of key staff with the team structure to meet the demands of the project including the aspects of complexity is an artful task.

Managing the Complexity

Once an understanding of the environment and of the capabilities of the project team exists, tactics can be identified to minimise the impact that complexity will have on a project. This should be framed by the four aspects of complexity:

1. **Structural**: many different interconnected tasks and activities. Tactics will include:
   - Review of the project structure and how teams (units) are formed including size and participant characteristics. Unit status and competition are also factors.
   - Assess the autonomy of the networked units and health of lateral relationships. Intervention processes for task clarity and timescales is important.
   - Assess how activities are grouped and communicated both vertically down the project structure to the unit owner, as well as, across (horizontally) to supporting resources.
   - Leveraging of data management principles such as data modelling, data governance, metadata, data stewardship.
   - Implementing Knowledge Management frameworks such as ISO5037

2. **Technical**: unique design challenges without precedents. Tactics will include:
   - Upskilling of team in Design Thinking (human centred design, empathy mapping, prototyping, iteration, etc.).
   - Revisit the design planning process and outputs. Focus on information dependencies, sequences of work, decision making processes, and how the process is being managed.
   - Assess the control of design changes including how implications are assessed and the sequencing of their implementation.

3. **Directional**: hidden agendas or mis-aligned goals. Tactics will include:
   - Assigning an executive ‘steward’ to a project. Someone who can remain objective, work closely with the team as a trusted advisor, and help manage key stakeholders.
   - Using the PMO as an outside perspective to challenge the project team, to generate insights, and connect the dots that they may otherwise be too close to.
   - Review the project brief and how it is being maintained. This should include a return brief, including a reconciliation of the customer requirements and project constraints (e.g. budget).

4. **Temporal**: uncertainty from shifting environmental conditions. Tactics will include:
   - Review opportunities to invest in the option to take future courses of action without having the obligation to follow that action.
   - Call out missing information and try to confine the impact it has on the project.

Dependent on the area that is identified as the key constraint for the project, budget and contingency allocations should reviewed.

Timing of Decisions

A risk assessment of the project with a focus on complexity will identify what Luft and Ingham (1955) describe as a new set of ‘known unknowns’ that will lead to an initial round of actions to eliminate, isolate, substitute, etc. these risks. It is important to understand the impact that timing of decisions has due to the large amount of ambiguity inherent in complex risks.
In many instances, the desire for action by a stakeholder pushes project decision too early. Symptoms include the overuse of committees and ambiguity on decision rights (anyone can say no, but nobody can say yes). Mitigations include focusing on missing information, articulation of the best and last points in time for decisions, and investigations into options that will extend decision timing windows.

Alternatively, a management team may be reluctant to shift away from ‘hands-on solution work’ and may cause project decisions to be made too late. Symptoms include continual firefighting and planning activities not being valued. The reluctance to delegate can be from a lack of confidence in the team or from their own discomfort in defining and assigning problems. Mitigations include resource gap analysis and management team mentoring.

When the right timing exists, decision making will start to become a ‘pull process’ from the networked teams rather than being ‘pushed’ by the management team.

**Conclusion**

By setting an enterprise framework, leveraging the PMO function, and creating a sensitivity to complexity, a business will have the tools to understand the complexity inherent in their portfolio. By augmenting the PMO with capabilities to evaluate complexity in project environments and assess abilities and behaviours of project delivery teams, a business will be able to successfully manage the risks of that complexity.

In the final article of this three-part series, enterprise architecture and data management strategies will be identified to help manage complexity on projects. Automated data collection and processing of large quantities of information can provide projects and businesses with insights at the same velocity as the risks they face.
References

Designing for Situation Awareness, Mica R. Endsley and Debra G. Jones, CRC Press, 2012
Enterprise Programme Management, David Williams and Tim Parr, Deloitte, 2006
ISO 15288:2015 Systems and software engineering - System life cycle processes
Designing Effective Organizations: How to Create Structured Networks, Michael Goold and Andrew Campbell, John Wiley & Sons Inc, 2002
The Johari window, a graphic model of interpersonal awareness, Joseph Luft and Harrington Ingham, Proceedings of the western training laboratory in group development. Los Angeles: University of California, Los Angeles, 1955